are message bandwidth and amplitude. We cannot exploit signal structure to achieve a more efcient communication system.

- **Performance**: Because of the Noisy Channel Coding Theorem, we have a specifc criterion by which to formulate error-correcting codes that can bring us as close to error-free transmission as we might want. Even though we may send information by way of a noisy channel, digital schemes are capable of error-free transmission while analog ones cannot overcome channel disturbances; see this problem (Information Communication Problems (Page 325)) for a comparison.
- **Flexibility**: Digital communication systems can transmit real-valued discrete-time signals, which could be analog ones obtained by analog-to-digital conversion, and symbolic-valued ones (computer data, for example). Any signal that can be transmitted by analog means can be sent by digital means, with the only issue being the number of bits used in A/D conversion (how accurately do we need to represent signal amplitude). Images can be sent by analog means (commercial television), but better communication performance occurs when we use digital systems (HDTV). In addition to digital communication's ability to transmit a wider variety of signals than analog systems, point-to-point digital systems can be organized into global (and beyond as well) systems that provide efficient and flexible information transmission. **Computer networks**, explored in the next section, are what we call such systems today. Even analog-based networks, such as the telephone system, employ modern computer networking ideas rather than the purely analog systems of the past.

Consequently, with the increased speed of digital computers, the development of increasingly efficient algorithms, and the ability to interconnect computers to form a communications infrastructure, digital commu nication is now the best choice for many situations.

## 6.33 Communication Networks



Communication networks elaborate the Fundamental Model of Communications (Figure 1.4: Fundamental model of communication). The model shown in Figure 6.25 describes **point-to-point** communications well, wherein the link between transmitter and receiver is straightforward, and they have the channel to themselves. One modern example of this communications mode is the modem that connects a personal computer with an information server via a telephone line. The key aspect, some would say faw, of this model is that the channel is **dedicated**: Only one communications link through the channel is allowed for all time. Regardless whether we have a wireline or wireless channel, communication bandwidth is precious, and if it could be shared without significant degradation in communications performance (measured by signal-to-noise ratio for analog signal transmission and by bit-error probability for digital transmission) so much the better.